Management and Treatment of Dentin Hypersensitivity not Associated with a Significant Loss of Tooth Structure

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Abstract

Dentin hypersensitivity (DH) is viewed by individuals as an important health problem and it is reported by the patient as a sharp pain caused by different external stimuli in dentin exposure.

Objective: To describe the best approaches for DH treatment, mainly in cases with no clinically significant loss of tooth structure.

Review: Several different approaches (in office and at home) have been proposed to control DH, including root coverage surgery, lasers application, and toothpaste and desensitizer application. The current review explores these treatments, especially in relation to their efficacy, limitation and safety.

Conclusion: The association of at home and in office treatment must be performed. At home treatment promotes maintenance and biodisponibility of desensitizing agents in oral environment.

ABBREVIATIONS

DH: Dentin Hypersensitivity

INTRODUCTION

Dentin hypersensitivity (DH) is characterized by pain arising from exposed dentin in response to thermal, evaporative, osmotic, tactile, or chemical stimulus [1,2]. Clinically, DH is described as a brief and sharp pain that affects one or multiple teeth simultaneously [3]. This exposure may be due to enamel loss on the cervical region, as well as gingival recession with cementum loss. Dentin exposure, loss of dental structure and DH is often related to noncarious lesions such as attrition, abrasion, and erosion and most of the time because of the association of these factors [4]. Regardless of dentin exposure etiology, there is a close relation between the outer environment and the odontoblastic cells caused by the opened dentin tubules [5] even in initial lesions.

Nowadays, the most widely accepted biological mechanism for DH is the hydrodynamic theory [6,7]. The theory asserts that the dentinal fluid flow induced by external stimulus may activate pulpal nociceptor, resulting in pain [6,8-10]. These external stimuli increase outward fluid flow within tubules, inducing shear stress on the receptor nerves in the tubule, causing hypersensitivity [6,7]. In this direction, treatment protocols should be discussed (Table 1), and performed especially in the cases where the loss of structure is not huge but able to make the patient uncomfortable.

The best treatment for DH has been widely discussed, and a number of clinical protocols have been reported. Restorative materials are indicated when there is loss of dental structure [2]. In this way, glass ionomer, resin-reinforced glass ionomer cements, and resin composite are considered the best choices of materials, once they provide a physical barrier against stimulus from the outer environment, decreasing the fluid motion inside the dentin tubules [2].

Several treatment protocols for DH are managed before any significant loss of dental structure occurs, including root coverage surgery, NdYAG laser application, use of toothpaste, and in office desensitizer application. Treatment (at home or in...
A dissolution and remineralization of hydroxyapatite crystals, can occlude dentin tubules by a fusion mechanism, it causes on the exposed dentin area. On another hand, high frequency laser neural transmission inside the pulp rather than acting directly depolarization of C-afferent fibers [18]. It induces changes in the Low frequency lasers act on nerve transmission through the immense heat and power when focused at close range [17]. regions. The waves in these phases are capable of mobilizing into a chromatic radiation in the infrared, ultraviolet, and visible regions. The waves in these phases are capable of mobilizing into a chromatic radiation in the infrared, ultraviolet, and visible regions. The waves in these phases are capable of mobilizing into a chromatic radiation in the infrared, ultraviolet, and visible

Methods

A search in the databases Pub Med, Scielo, and MEDLINE was conducted and limited to dental journals in English language, using the following search terms: dentin sensitivity, toothpastes, dentifrice, root coverage surgery, gingival surgery, dentin, lasers and adhesives. Titles, abstracts, and articles were reviewed, and the papers in accordance to scientific evidence were selected.

Root coverage surgery

Periodontal plastic surgeries such as root coverage have been used to treat DH caused by gingival recession [11,12] aimed at decreasing the exposed dentin. The principal objective of root coverage surgery is complete coverage of the defect in the cervical region, promoting good appearance and minimal probing depth after healing [13-15]. To predict the results of this procedure, the clinical conditions of the patient should be analyzed with caution. For the indication of root coverage procedure, it is very important to evaluate the height of the interdental periodontal support, including clinical attachment and alveolar bone levels [16]. Thus, the success of the root coverage surgery is directly related to the clinical conditions of each patient, and a limitation of this technique is that the recession of area initially protected with the surgery procedure can occur after some time, leading to dentin exposure again.

Laser application

Laser is a device that transforms light of different frequencies into a chromatic radiation in the infrared, ultraviolet, and visible regions. The waves in these phases are capable of mobilizing immense heat and power when focused at close range [17]. Low frequency lasers act on nerve transmission through the depolarization of C-afferent fibers [18]. It induces changes in the neural transmission inside the pulp rather than acting directly on the exposed dentin area. On another hand, high frequency laser can occlude dentin tubules by a fusion mechanism, it causes a dissolution and remineralization of hydroxyapatite crystals, forming a remineralized layer, which is responsible to eliminate/ decrease the DH for a long period of time [19,20], as it occludes the opened dentin tubules.

Studies regarding the application of diode lasers have shown that they act directly in the pulp, increasing the metabolic activity of odontoblastic cells that occludes the dentin tubules, and further increases the tertiary dentin formation [21,22]. However, the major limitation of the laser technique is the need of a skilled professional for the use of laser apparatus, in addition to its high treatment cost.

Toothpaste

Dentifrices are the first choice for the treatment of DH, especially in cases not associated with a significant loss of tooth structure. Toothpaste promotes maintenance of desensitizing agents in oral environment. Therefore, the present manuscript focuses on the different modes of action of dentifrices in treating DH, as reported below. All modes can decrease or eliminate the DH.

Disrupting the neural response to external stimulus:

Potassium salts are the only dentifrice compounds capable of blocking the neural response, and the most common potassium salts used in dentifrices are potassium nitrate, potassium chloride, and potassium citrate. These salts reduce the excitability of pulp nerve fibers and their prolongations, thus blocking the neural response to painful stimulus [23,24].

Several studies have shown the therapeutic efficacy of potassium salts to reduce the DH [25-30]. It is a consensus that the desensitizing effect starts after 2 weeks of dentifrice use, with significant reduction within 4 to 8 weeks. However, the desensitizing effect stops as soon as the dentifrice use is interrupted. The treatment of DH using dentifrices is not indicated to patients with acute hypersensitivity, as it does not provide immediate and long-lasting relieve of pains.

Occlusion of open dentin tubules:

The principle of occluding the exposed and open dentin tubules is quite interesting, once it blocks both the stimulus and symptoms. It can occlude the tubules and avoid the hydrodynamic mechanism inside the dentin tubules through two modes of action: 1) precipitation of a thin particle layer over the exposed dentin [31], which is provided by strontium- or stannous fluoride-containing dentifrices; 2) use of insoluble crystals formed by the precipitation of minerals rich in calcium and phosphate or by the precipitation of metallic ions so that they act directly in the pulp, increasing the metabolic activity of odontoblastic cells that occludes the dentin tubules, and further increases the tertiary dentin formation [21,22]. However, the major limitation of the laser technique is the need of a skilled professional for the use of laser apparatus, in addition to its high treatment cost.

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Table 1: Treatment approaches of dentin hypersensitivity and mechanisms of action.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Management</th>
<th>Mechanism of Action</th>
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<tbody>
<tr>
<td>Pro-Argin®</td>
<td>At home- dentifrice</td>
<td>Occlusion of dentin tubules by the precipitation of saliva ions and glycoprotein</td>
</tr>
<tr>
<td>Novamin®</td>
<td>At home- dentifrice</td>
<td>Occlusion of dentin tubules by the precipitation of minerals rich in calcium and phosphate</td>
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<tr>
<td>Strontium salts</td>
<td>At home- dentifrice</td>
<td>Occlusion of dentin tubules by the precipitation of a thin mineral layer</td>
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<tr>
<td>Potassium salts</td>
<td>At home- dentifrice</td>
<td>Cellular depolarization blocking the neural response</td>
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<tr>
<td>Stannous fluoride</td>
<td>At home- dentifrice</td>
<td>Occlusion of dentin tubules by the precipitation of metallic ions</td>
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<tr>
<td>Oxalate</td>
<td>In office</td>
<td>Reaction with calcium ions present on dentin surface forming calcium oxalate insoluble crystals</td>
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<tr>
<td>Laser</td>
<td>In office</td>
<td>Nerve fibers depolarization and/or occlusion of dentin tubules</td>
</tr>
<tr>
<td>Root coverage surgery</td>
<td>In office</td>
<td>Coverage of exposed dentin with surrounding gingival</td>
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<tr>
<td>Adhesive system</td>
<td>In office</td>
<td>Seal the dentin tubules through the formed hybrid layer</td>
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of new technologies based on calcium carbonate and arginine (Pro-Argin®) or bioactive glass (Novamin®), which allow the formation of calcium phosphate minerals in situ [31].

Strontium can replace the missing calcium from hydroxyapatite crystals, thus strengthening the dentin structure [32,33]. However, it is likely that strontium is deposited as a thin layer over the exposed dentin to occlude the dentin tubules [32,33]. Although previous in vitro studies have found a synergy between strontium acetate and silica to occlude dentin tubules [34,35], in vivo studies about the efficacy of strontium salts in decreasing the DH are not conclusive [36]. Thus, recently, strontium-containing dentifrices have not been indicated to control DH. In contrast, stannous fluoride-containing dentifrices promote the obliteration of dentin tubules by the precipitation of insoluble metallic compounds [37], with immediate efficacy up to 4-8 weeks [38], mainly when associated with sodium hexametaphosphate.

Arginine is an amino acid that is adsorbed on the calcium carbonate surface, allowing the formation of positively charged agglomerate that is attracted by the negatively charged dentin surface [39]. This agglomerate is able to react with ions and glycoproteins present in saliva, and the reaction product can precipitate on the dental surface, obliterating the dentin tubules and thus decreasing the DH. Previous studies have shown that arginine-based dentifrices reduce significantly the DH immediately after the direct application, and the patient is encouraged to continue using this toothpaste to keep its effect against DH [40-42].

Bioactive glass is a material able to bond chemically to dental tissues. It is composed by calcium, sodium, phosphorous, and silica, in amounts that provides the bioactivity to the material [43]. The great bioavailability of calcium, phosphorous, and sodium enables the attraction of these ions to dentin collagen, leading to mineral precipitation (crystalline hydroxycarbonate apatite), which is very similar to natural dental apatite. This precipitated mineral might occlude the opened dental tubules [44]. The bioglass-based dentifrices have proven efficacy [45] after 6 to 8 weeks [46], present longer duration, and have acid resistant properties [47].

**Application of desensitizing agents (in-office)**

The active principles of the dentifrices to treat DH, such as potassium salts, arginine, and bioactive glass are also effective for in office applications. The mechanism of action is not discussed in this topic, as it was previously mentioned. In office treatment differs from at home treatment especially in relation to the concentration of the products and the way of application [1]. Products to be used in office applications are commercialized in the form of paste and gels.

The potassium oxalate gel treated-dentin showed great crystals deposition into the tubule lumen. The gel enters into the tubule and reacts with calcium ions on dentin surface, forming insoluble calcium oxalate crystals [48-50]. The precipitation of crystals occurs into the tubule and it is extended 15 µm deeper, thus occluding the tubule. Moreover, the increase in potassium ions in the extracellular tubule may cause depolarization of nerve fibers [51,52].

In addition to all protocols mentioned in the present study, the adhesive systems can also be used to treat DH. The hybrid layer formed after the polymerization of adhesive systems has a sealing effect on the exposed dentin [53], preventing fluid movements into the tubule, and thus the DH. Therefore, the adhesive systems have immediate effect in the prevention of pains. The advantages of using adhesive systems are the easy management of this technique and the possibility of reaplication in cases of pain recurrence over time. The disadvantage includes the hydrolytic degradation of the adhesives over the time, as they contain a great amount of hydrophilic monomers in their composition. However inorganic fillers-containing adhesives can be used to prevent the degradation, as they are less susceptible to sorption mechanism [54].

The Gluma Desensitizer (Heraus, Germany) system can also be effective for treatment of DH. This product is composed by glutaraldehyde and hydroxyethyl methacrylate (HEMA) aqueous solution, to promote a desensitizer effect up to 9 months [1]. Glutaraldehyde can react with the albumin present in dentin fluid, and the resulting precipitate clears or occludes the dentin tubule [52].

**DISCUSSION AND CONCLUSION**

The choice of the best treatment for DH is a challenge, once several protocols and products are found in the dental market (Table 1). The indication of each treatment will depend on both the degree of dentin hypersensitivity, and loss of dental structure, which can be carried out at home or in dental office. Although there are several techniques for root coverage, the success of surgical therapy is directly related to the clinical conditions of each patient, which cannot be successful in some cases [55,56].

Among the several methods to treat DH, the toothpastes are widely indicated due their low cost and easy application. Furthermore, the toothpastes allow to a high exposure to the active compounds responsible to decrease the pain [31]. Besides being indicated for daily use, it has great patients’ acceptance and lower costs when compared with other treatments, with efficacy in control the DH [31]. Moreover, the dentists should indicate less invasive treatments as a first choice; the treatments at home are considered noninvasive and should be preferred.

When treatment with toothpastes in not effective, other treatments can be indicated, however, they may not be yet effective. The laser therapy is a technique that requires skilled professional and equipment, leading to high costs of treatment, thus limiting patient access [17,21]. The application of adhesive or desensitizer compounds have proven to be effective [50,52,53], however its duration decreases over time. In relation to the desensitizing agents (in-office), there is a short contact with the affected area [12]. The adhesive systems are composed of materials with low load concentration and high solubility in oral environment, thus, the continuous applications of these products are required [57].

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